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present the novelty of viewpoint which is peculiar to parts of books such as those by Bunge and Abderhalden. The element of propaganda is nowhere present; but as an orderly arranged storehouse of contributions to the literature it remains unsurpassed. Many of us have learned to depend upon Hammarsten's "Physiological Chemistry" as a reliable help of almost cyclopædic comprehensiveness. Both the author, on the eve of his retirement from active teaching, and the translator have rendered a further useful and creditable service.

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Devonic Fishes of the New York Formations.

By CHARLES R. EASTMAN. New York State Museum, Memoir 10. Albany, New York State Education Department. 1907. Pp. 1-235, plates 1-15.

This is unquestionably the most important contribution to the study of American fossil fishes since the publication of Newberry's classic monograph nearly two decades ago.¹ It embodies the results of years of painstaking research; is carefully elaborated, beautifully illustrated and, like everything else from Dr. Eastman's pen, clearly and interestingly written.

It is, of course, out of the question to attempt here a discussion of the many novel facts and interpretations in which the memoir abounds. We may only touch here and there upon some point of special importance.

One of the valuable features of the memoir consists in the large number of new forms and new localities that are put on record. The most noteworthy among these, perhaps, is that of the discovery in America of the genus *Asterolepis*. This is represented by only a single armor plate, unfortunately, but the figures and description leave no doubt that the specimen is an *Asterolepis*. It comes from a lower Devonian horizon (Chapman sandstone of Maine)—a circumstance of high importance; for inasmuch as all the European

species² of *Asterolepis* have come from the Upper Devonian, the present specimen carries the history of the genus farther back in time than hitherto known. It proves, too, that the organisms of the antiarchan style of structure attained high specialization as early as the Lower Devonian, when they were already represented by three genera, *Asterolepis*, *Pterichthys* and *Microbrachius*, thus making almost positive the indication that the ancestors of the Antiarcha may one day be discovered as far back as the Upper or Middle Silurian.

There are also described a new species of *Ptyctodus*, one of *Machæracanthus*, one of *Cladodus*: the last, represented by a tooth from the Middle Devonian of Ohio which is declared to represent the oldest cladodont shark yet known (p. 62). Judging by its size one must infer that the cladodonts of that early day had already taken on goodly proportions.

Among arthrodiran "fishes" an interesting small dinichthyid is described, *Dinichthys dolichocephalus*; a new *Glyptaspis*, and a new genus *Protitanichthys*. In connection with this new genus, the type of which (a cranial shield) I have had the opportunity of examining, thanks to the kindness of Dr. Eastman, I regret that I can not put myself in accord with the interpretation given by the author. Dr. Eastman regards this form as a primitive *Titanichthys*—chiefly because the head shield has a pineal element that is broader than long. But this fact, in the reviewer's opinion, is rather inadequate proof that the species is a Titan. *Titanichthys* is not the only Arthrodire with an abbreviated pineal, Dr. A. S. Woodward having long since shown the presence of such a pineal in *Phlyctænaspis*.³ And, moreover, a careful study of the type specimen shows the pineal to be really elongated as in typical coccosteids. What Dr. Eastman figures as the posterior suture of the abbreviated pineal, I am convinced, is

¹With the reservation indicated by Eastman (p. 40, foot-note), in favor of the obscure fragments described by Pander from the Silurian of the Baltic provinces.

²*Geological Magazine*, Vol. IX., 1892, pl. i, fig. 8.

³"The Paleozoic Fishes of North America," Monograph U. S. Geol. Survey, XVI., 1889.

but a transverse flexure across the middle of that plate proper. But even apart from the question of the shape of the pineal element, the genus *Protitanichthys* is obviously founded on doubtful grounds. As Dr. Eastman himself points out (pp. 144, 145), it is extremely probable that this cranial shield belongs to a true *Coccosteus*, perhaps to *C. occidentalis* or to the so-called *Liognathus spatulatus*, both of which are known only from single elements found in the same formation (Delaware limestone, Delaware, Ohio). In view of these considerations it appears to me that the name *Protitanichthys* itself is objectionable. The prefix *Pro* in generic names ought to be rigidly restricted to such cases only where the evidence for ancestral relationship amounts to practical certainty, as, for instance, in the phylogenetic series of the horses or the camels.

In regard to *Acantholepis*, also, we are forced to dissent from Dr. Eastman's interpretation. Newberry and others have shown that the objects so named are dermal defenses of some indeterminable Arthrodire or Ostracophore. Now Dr. Eastman rejects this interpretation and advances the view, upon very slender evidence, that they are "dermal defenses of Chimæroids, probably dorsal fin-spines" (p. 78). He speaks of these spines as having exserted and inserted moieties, though admitting (p. 79) that the inserted part has never been observed.

A few minor slips have crept into the text—a circumstance not surprising when one considers the mass of detail dealt with. Thus it is stated that no dinichthyid is known to have symphyseal denticles (p. 126), when in 1906 the reviewer published two figures of a mandible belonging to the Newberry collection which clearly displays some ten such denticles.⁴

On one or two points we could wish that the figures had been fuller. For instance, a description is given of what Dr. Eastman interprets as the parasphenoid of *Macropetalichthys*. When one considers that the structure so named by our author has never been

adequately described; that among those having intimate first-hand acquaintance with the specimens some go the length of denying that any structure homologizable with a parasphenoid at all exists in *Macropetalichthys*, or indeed in any arthrognaath; one wishes that this debatable element had been carefully illustrated, so that whoever wished might judge whether this be a parasphenoid or not. One also could wish that the dentition of that primitive form *Dinichthys halmodeus* had been figured so that we could have arrived at a clear concept of the peculiarities of these interesting structures.

And lastly, this review were inadequate indeed, did we not touch upon Dr. Eastman's views on the relationships of the *Arthrodira*—a group upon which he has bestowed considerable time and effort during the past few years and which occupies no less than a quarter (68 pages) of the present memoir. Indeed, his view of the affinity of the *Arthrodira* is the veritable *Leitmotif* which runs through his entire discussion of the group.

This theory may be briefly stated as follows: a Paleozoic dipnoan gave off two lateral branches of lung fishes. One of these flourished through several geological periods, giving rise to *Dipterus*, *Ctenodus*, *Uronemus* and the like, finally becoming extinct; the second branch, constituted the stock of the *Arthrodires*, evolved a galaxy of forms, only to become extinguished at the close of the Devonian. The central stock of primitive ceratodonts, on the other hand, continued essentially unmodified through all later geological periods and is represented at the present day by the existing lung-fishes.

Hence Dr. Eastman upholds two distinct theses: (1) that a ceratodont, not a dipterine, exemplifies most nearly the primitive dipnoan; and, (2) that the *Arthrodira* are specialized offshoots of this primitive ceratodont.

The first of these theses, although contravening the widely accepted view elaborated by Dollo and others, our author does not treat at any length in this memoir and we need not, therefore, go into it.⁵ As for the second, the

⁴ *Mem. Amer. Mus. Nat. Hist.*, IX., 1906, p. 118, fig. 11, and p. 149, fig. 25 C.

⁵ For a critique of Dr. Eastman's views on this

reviewer has already in part expressed his opinion⁶ and Dr. Eastman's renewed arguments have not led him to alter his point of view.

The central argument against Dr. Eastman's theory of the dipnoan affinity of the Arthrodira seems to the reviewer to be that he lays too much stress on a single character—the resemblance of the crushing dentition of the ceratodonts to that of *Mylostoma* among arthrodiras. This resemblance he interprets as an homology and makes it one of the cardinal arguments for relationship. But why may not this partial resemblance in dentition be a case of parallelism, of adaptation to similar food, in two widely different groups?—especially so in view of the wide differences between arthrodiras and dipnoans in other regards, and because of the frequent occurrence among fishes of adaptations to a similar hard diet. It seems to the reviewer that a close examination of Dr. Eastman's argument for the homology of the ceratodont and arthrodiran dentitions, especially the exposition on pages 150–151, will hardly carry conviction to the mind of the critical reader.

But the establishment of homology between ceratodont and arthrodiran dentitions is the crucial point in Dr. Eastman's theory. Reject this central argument as not proved or, if you please, as *sub judice*, and little evidence remains, at least in the reviewer's opinion, to support the thesis of a genetic affinity between arthrodiras and dipnoans. Some of the adduced evidence must, in fact, be ruled out of court as not material to the present case, for instance the question of the shape of the caudal fin⁷ or of the homology of certain skeletal elements.

Furthermore, as Professor Dean has recently urged, there are certain absolutely irreconcilable differences between arthrodiras and subject see a review by Professor Bashford Dean in SCIENCE, July 12, 1907, p. 48.

⁶ *Mem. Amer. Mus. Nat. Hist.*, IX., 1906, pp. 126–128.

⁷ For, granted even that *Coccoosteus* had a diphyccercal tail, and that fact does not alter the balance of evidence, since a diphyccercal tail is not an exclusively dipnoan character.

dipnoans; for instance, the presence in all arthrodiras of a complicated dorsal and ventral body-armor constructed on one plan and with complicated neck joints, and its absence in all dipnoans.

And again, the characters linking the arthrodiras with the Ostracophores to which writers have again and again called attention within the past half century, are surely not dipnoan.

These are only some of the broader criticisms against Dr. Eastman's views on the affinity of the arthrodiras. Did space permit, we might profitably examine certain of the subsidiary hypotheses and conclusions and point out minor difficulties and discrepancies which weigh against Dr. Eastman's main thesis. But enough has been said, we believe, to indicate some of the chief grounds for dissenting from our author's view that the Arthrodira are specialized dipnoans.

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Variations and Genetic Relationships of the Garter Snakes. By ALEXANDER G. RUTHVEN. United States National Museum, Bulletin 61, pp. 201. 1908.

In these days of minute analysis on the part of systematic zoologists, an acute and exact study of variation with a synthetic purpose comes as rest to the weary.

The courage displayed by Dr. Ruthven in giving reasons for his scheme of genetic relationships in this impracticable group can be best valued by other herpetologists who have ventured on the same task and have been carefully secretive as to how they did it. As one of these I may be privileged to both praise and criticize this excellent paper.

Nothing but good can be said of the method adopted by the author in carefully estimating the value of the characters commonly held to be specific in snakes, and of the painstaking care with which it has been followed to the end. It is an ingenious bit of demonstration, and one easily verifiable, which shows that reductions in the number of rows of dorsal scales as girth of body decreases in the in-